CLAIMS

Therefore, having thus described the invention, at least the following is claimed:

1. An apparatus for examining the internal structure of a material, the apparatus comprising:

an x-ray source adapted to emit an x-ray beam at the surface of a target area of the material;

an x-ray detector adapted to detect x-rays diffracted from the target area of the material; and

a mounting plate having the x-ray source and the x-ray detector rigidly mounted thereto, wherein the x-ray source and the x-ray detector are aligned on the mounting plate such that the x-ray beam emitted from the x-ray source is incident upon a given crystallographic plane atoms in the target area of the material at the Bragg angle for the given crystallographic plane of atoms and the x-ray detector is configured to detect the x-rays diffracted at the approximate Bragg angle.

2. The apparatus of claim 1, wherein the mounting plate is adapted to have the x-ray source and x-ray detector rigidly mounted thereto in a finite number of alignments.

3. The apparatus of claim 2, wherein for each alignment, the x-ray source and x-ray detector are aligned such that the x-ray detector detects x-rays that were emitted by the x-ray source and diffracted from a particular crystallographic plane of atoms at the approximate Bragg angle for that particular plane of atoms.

4. The apparatus of claim 2, wherein the mounting plate defines multiple sets of alignment bores, each set of alignment bores configured to align and rigidly couple the x-ray source and the x-ray detector to the mounting plate.

5. The apparatus of claim 1, further including:

a photo-spectrum analyzer mounted to the mounting plate and adapted to measure spectral intensity across a range of frequencies for electromagnetic radiation emitted from the target area of the material.

6. The apparatus of claim 1, further including:

an x-ray source controller in communication with the x-ray source, the x-ray source controller adapted to provide electrical power and initiation and operation parameters to the x-ray source.

7. The apparatus of claim 1, further including:

a storage device in electrical communication with the x-ray detector, wherein the storage device stores information related to the angular dispersion of the diffracted x-rays.

8. A method for examining the internal structure of a component, the method comprising the steps of:

aligning an x-ray source and an x-ray detector in a rigid and predetermined orientation;

irradiating a target area of a surface of a component with an x-ray beam from the x-ray source, wherein the x-ray beam is incident upon a particular crystallographic plane of atoms at the Bragg angle for that plane;

detecting x-rays diffracted from the target area of the component with an x-ray detector, wherein the intensity of the diffracted x-rays exhibits a peak at a given angle, θ, and θ is the approximate Bragg angle for the diffracting crystallographic plane of atoms, and wherein the rigid predetermined orientation of the x-ray source and x-ray detector is such that the x-ray detector measures the peak in intensity of the diffracted x-rays; and

determining an indicator of the internal structure from the intensity as a function angular dispersion of the diffracted x-rays detected by the x-ray detector.

9. The method of claim 8, further including the steps of:

enumerating the number of x-rays detected by the x-ray detector over a range of angles; and

parameterizing the number of x-rays detected as a function of angle.

10. The method of claim 9, wherein the indicator of the internal structure is a parameter used in the parameterization of the number of x-rays counted as a function of angle.

11. The method of claim 8, further including the step of:

identifying the composition of the component.

12. The method of claim 11, wherein the step of identifying the composition of the component includes the steps of:

measuring across a frequency range the intensity of light fluoresced from the composition to determine the spectral characteristics of the composition; and

comparing the spectral characteristics of the composition with spectral characteristics of known materials.

13. The method of claim 8, further including the step of:

mounting the x-ray source and the x-ray detector rigidly and removably on a mounting plate, wherein the mounting plate is adapted to have the x-ray source and x-ray detector rigidly and removably coupled thereto in multiple alignments, wherein for each of the multiple alignments the angle between the x-ray beam emitted from the x-ray source is at Bragg angle for a particular crystallographic plane of atoms and the x-ray detector is aligned to receive the diffracted x-rays at the Bragg angle.

14. The method of claim 8, further including the step of:

determining the remaining lifetime of the component using the internal structure indicator and a database, wherein the database includes structure indicators having lifetimes associated therewith for multiple test objects.

15. The method of claim 8, wherein the component is part of a system and is scanned in situ.

16. An apparatus for non-destructively examining the internal structure of a component, the apparatus comprising:

an x-ray source;an x-ray detector; and

a mounting system having the x-ray source and the x-ray detector rigidly mounted thereon, wherein the x-ray source emits an x-ray beam that is at least partially diffracted from the component, and the x-ray source and the x-ray detector are aligned such that the x-ray detector detects a peak in the intensity of the diffracted x-rays, wherein the mounting system is adapted to have the x-ray source and the x-ray detector mounted in multiple configurations; and

a housing defining an exterior surface and a generally hollow interior having the mounting system therein, the housing defining a window extending from the interior to the exterior surface, the window adapted to have an x-ray beam generated in the housing pass through the window;.

17. The apparatus of claim 16, wherein the mounting system is an interior wall of the housing.

18. The apparatus of claim 16, wherein the mounting system includes a plate mounted to an interior wall of the housing.